Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

TITLE: **CATHODE PLATE**

TECHNICAL FIELD

The present invention relates to a cathode plate for use in electro-deposition of metal.

BACKGROUND ART

There are various processes and apparatus for electro-refining or electro-winning metal.

One particularly successful process for electro-depositing of copper for example is the so-called ISA PROCESS in which copper is deposited on a stainless steel cathode mother plate. The electrolytically deposited copper is then stripped from the cathode by first flexing the cathode to cause at least a part of the copper deposit to separate from the cathode and then wedge stripping or gas blasting the remainder of the copper from the cathode.

In the ISA PROCESS the bottom edge of the cathode mother plate is generally covered with a release compound such as wax or a plastic edge strip to prevent deposition of copper thereon. This allows for removal of the electro-deposited copper as substantially equivalent separate sheets from both sides of the cathode plate. Such waxing of the cathode sheet, however, is time consuming and there is added cost both for applying the wax and for recovering the wax from the stripping process and associated housekeeping.

To avoid these difficulties, some electro-refining/electro-winning operations use a so-called enveloped cathode process. In such a process the lower edge of the cathode

sheet is not waxed and the electro-deposited metal is allowed to grow on both sides of the sheet and around the bottom edge of the cathode mother plate.

Removal of the electrolytically deposited envelope of metal is then accomplished by flexing the cathode and pulling back the metal from both sides of the sheet so that it forms a V. The cathode mother plate is then removed from between the electrolytically deposited envelope of metal, the envelope is then closed and rotated from its vertical position to a horizontal position and transported to a stacking/bundling station.

Not only does such a removal process require complex apparatus for opening the metal envelope, removing the cathode mother plate prior to closing of the envelope and rotating the envelope from the vertical to the horizontal position for stacking, such an arrangement is time consuming and generally not as quick as the ISA PROCESS stripping step.

In conjunction with other parties, the applicant has recently developed a new process in which an envelope of metal is formed on the stainless steel cathode mother plate and then stripped into two separate sheets. This process is subject of co-pending International Patent Application No. PCT/FI99/00979. By way of summary, the new process will be discussed with reference to figures 1A-1D and 2A-2D attached herewith.

The initial step in stripping an electrolytically deposited metal envelope from its cathode mother sheet is to at least partially separate either side of the deposited envelope from the cathode sheet. In this regard reference is made to figures 1A-1D. The enveloped cathode comprises cathode sheets 20 and 30 deposited on the cathode mother sheet 10 and joined along the lower edge thereof by a frangible portion 40. The cathode

mother sheet is firstly flexed to provide separation of at least the upper end portion 50 of the sheets 20, 30.

The partially separated envelope as shown if figure 1D is then subjected to a stripping operation as shown in figures 2A and 2B. The partially separated sheets 20 and 30 are positioned in a stripping apparatus on rollers or conveyor belt 50. The apparatus includes a wedge stripper or air blaster 130. These wedge strippers 130 enter the gap between sheets 20, 30 and cathode mother sheet 10. The wedge strippers 130 release the sheets 20 and 30 of the electro-deposited envelope from the cathode mother sheet 10. The sheets 20 and 30, however, are still held together by the frangible portion 40 extending along the bottom edge of the cathode sheet 10 as shown in Figure 2B. To effect full separation of the electro-deposited metal envelope into separate substantially equivalent sheets. These sheets are 20 and 30 is held by grippers 25, 35 and rotated about the frangible portion 40 from the substantial vertical position shown in figure 2B to the substantially horizontal position shown in figure 2C. This rotation separates the deposited metal into two substantially equivalent sheets. In many cases, a single rotation of the sheets 20, 30 from the vertical to the horizontal is all that is required to separate the sheets. This separation of the sheets 20 and 30 from each other as well as the cathode mother plate may be confirmed by the grippers 25, 35 as follows. The grippers which still hold the sheet 20, 30 in the horizontal position shown in figure 2C, are adapted to pull the respective sheets slightly outward as shown in figure 2D. If the sheets, 20, 30 move outwardly in unison with the grippers, separation of the sheets 20, 30 is confirmed. If, however, the force to move the grippers outward is too great or simply the grippers do not move this indicates that the frangible portion 40 has not in

fact separated the sheets 20, 30 and accordingly further rotation (as shown in figure 2C) of the sheets may be required.

If further manipulation/rotation of sheets 20, 30 is required, the apparatus using grippers 25 and 35 rotates sheets 20 and 30 upwardly and downwardly until the aforementioned confirmation of separation of the sheets is effected.

Once the cathode sheets 20 and 30 are separated into substantially equivalent separate sheets, it is a simple matter to transport the sheets out of the apparatus for stacking and subsequent treatment.

In some cases it is quite difficult to separate the envelope of deposited metal into two separate sheets. As will be appreciated, repeated rotation or flapping of the sheet portions can be quite time consuming and reduces the overall efficiency of the process.

Reference is made to Figure 3 which shows a groove 15 in a cathode mother plate 10 with deposited metal extending around the end of the cathode mother plate 10. This groove 15 is formed in the bottom edge of the cathode mother plate as a 'growth effecting means' as described in co-pending International Patent Application No. PCT/FI99/00979. The Applicant's have found, however, that even with groove 15 the deposited metal may not cleanly release from the cathode plate or split into two substantially equivalent sheets 20, 30. To explain, as shown in Figure 3, on occasion, the metal envelope separates into two sheets with a lip 25 attached to one sheet. This lip extends around almost the entire end portion of the mother plate 10. The fracture line 35 between metal sheets 20 and 30 is essentially on one side of the cathode mother plate 10 rather than being in the preferred frangible region 40 at the lower end of the mother plate.

It is an object of the present invention to overcome or ameliorate at least one of the disadvantages of the prior art, or to provide a useful alternative to the prior art.

DISCLOSURE OF THE INVENTION

In a first aspect, the present invention provides a method of electro-depositing an envelope of metal on a cathode said envelope including deposited metal on either side of said cathode and joined along at least one edge by a frangible portion, and being removable from said cathode by rotation of respective sides of the deposited metal envelope about the frangible portion to separate the deposited metal from the cathode into two substantially equivalent sheets,

the method comprising providing a groove on said cathode plate whereby metal deposited on and adjacent to said groove forms said frangible portion,

and wherein said groove is shaped such that a line of weakness is formed in the metal deposited within the groove such that separation of the two sheets of the deposited metal is initiated along said line of weakness.

In a first embodiment, the groove is shaped as a V, with the line of weakness being formed within the arc of the V.

In another embodiment the arc of the V-groove is between 75 and 105 degrees and most preferably the arc of the V-groove is substantially 90 degrees.

The present applicant has determined that the size and shape of the groove in the cathode mother plate has an impact on the ability to separate the deposited metal envelope from the cathode into two substantially equivalent sheets.

By appropriate sizing and shaping of the groove, it is possible to reliably provide a line of weakness between the two sides of the electro-deposited envelope, such that the

separation or splitting of two separate sides of sheets of the deposited metal envelope is initiated on the line of weakness within the groove.

If the line of weakness is not formed within the groove, the fracture line may be initiated outside the confines of the groove and in some cases may continue to propagate round the end of the plate to an exterior side of the cathode mother plate metal envelope as shown in Figure 3. The sheets may then fracture at a point outside the frangible region. Having such a line of fracture outside the frangible region creates difficulties in the stripping process. Firstly, it can render splitting of the two sheets quite difficult. In some instances it may be necessary to rotate or flap the sheets several times to provide separation. Clearly this is undesirable, and increases the residence time of the plate in the stripping machine and thereby slows production.

Further, having a line of fracture outside the frangible region will produce two sheets which are not substantially symmetrical or equivalent in size. One sheet may be essentially flat with another sheet having a small lip or hooked edge as shown in Figure 3. The resulting sheets with uneven edges are unsightly and difficult to handle particularly in high speed automated machinery.

The applicant has found that the size and shape of the groove can be tailored so that the line of weakness extending between the two sheets remains within the confines of the groove. The shape of the groove is a balance between allowing growth of the deposited metal in the groove while still permitting easy separation of the two sheets.

Indeed, in another embodiment the groove may be shaped to permit deposited metal to substantially fill the entire groove. In yet another embodiment, the groove is shaped to allow deposition of metal directly adjacent the apex of the groove.

In another aspect, the present invention provides a cathode plate for electro-deposition of metal, said cathode plate having a groove along at least one edge and shaped such that, in use, a line of weakness is formed in the metal deposited within the groove,

whereby during stripping of metal from said cathode, separation of the envelope of metal into two substantially equivalent sheets is initiated along said line of weakness.

Unless the context clearly requires otherwise, throughout the description and the claims, the words 'comprise', 'comprising', and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to".

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described by way of example only with reference to the accompanying drawings in which:

Figures 1A-2D are end elevational views of the process for stripping electro-deposited metal envelopes as developed by the applicant and are included for clarification purposes only.

Figure 3 is an end elevational view of a cathode mother plate with a deposited metal envelope partially stripped into two separate sheets,

Figure 4 is an end elevational view of an embodiment of the present invention,

Figures 5 and 6 are end elevational views showing different shaped bottom edges of cathode plates.

MODE(S) FOR CARRYING OUT THE INVENTION

Figures 1A-2D and Figure 3 all relates to prior art mechanisms and are discussed above.

The applicants have found that it is possible to tailor a groove in the lower end of the mother plate such that a line of weakness is formed in the groove to thereby permit reliable fracture of the deposited metal envelope into two substantially equivalent and preferably symmetrical sheets.

Reference is made to Figure 4 which shows cathode mother plate 100 with a V-groove 150 formed along its lower end edge. For the sake of simplicity, the arc of groove 150 shown in Figure 4 is 90 degrees, however, as will be appreciated from the foregoing it is not essential that the groove by V-shaped or that the arc of the groove equal 90 degrees.

The shape and size of V-groove 150 is designed to perform several functions. Its primary function is to permit separation of the deposited metal envelope 120 from the mother plate 100 into two substantially equivalent sheets 122 and 124.

How the V-groove provides this function will now be explained. As will be clear to persons skilled in the art, when the mother plate 100 is placed in an electrolytic cell for, say, electro-refining of copper, it is interspersed between copper anodes and substantially immersed in an electrolytic solution. The copper from the anodes enters the electrolyte for redepositing on the cathode. Generally, to provide a "full term" deposit the cathode remains in the electrolyte bath for between 5 and 14 days.

When the copper crystals are deposited on the metal cathode, they are deposited at substantially right angles to the deposition surface. This is shown by arrows in Figure 4. Generally, the copper will take the path of least resistance and endeavour to deposit on

the cathode as quickly as possible. Accordingly, it will be appreciated that it is easier for the copper to deposit on the exterior side surfaces 102, 104 of the cathode plate 100 rather than in the V-groove 150. It is important, however, that copper is deposited in the V-groove since when the copper envelope is removed from mother plate 100, by pulling on the opposite sides of the metal envelope as discussed above, fracture or crack initiation begins in the frangible region 140 at the lower end of the mother plate 100. It is desirable that this crack initiation begins at the apex of V-groove 150. Accordingly, it is preferable that V-groove 150 is shaped to allow deposition of copper in the V-groove adjacent the apex with the line of weakness extending between the arc of the V-groove 150.

The applicants have found that certain groove sizes and shapes permit such 'symmetrical' splitting of the deposited metal while others do not. For instance, a V-groove with an arc of 90° ± 15° allows growth of copper in the V-groove while providing a line of weakness as shown by dotted line A between the arc of the V-groove. When the deposited metal envelope is then removed, the position of line of weakness A in the V-groove causes the splitting of the deposited metal into two substantially equivalent sheets to initiate along the line of weakness or fracture line in the frangible region 140.

The groove 150 shown in Figure 4 can be compared with the V-groove shown in the Figures 5 and 6.

In Figure 5, a shallow V-groove 60 is shown. The shape of this V-groove 60 does not provide as great a resistance to deposition of copper as does groove 150 shown in Figure 4. Accordingly, copper is deposited quite readily in V-groove 60. This is

desirable. However. the applicants have found that due to the shape of groove 60, the length and hence effectiveness of the line of weakness is reduced. Thus a stronger bond is formed between the two sides of the metal envelope making it more difficult to split the metal envelope into two substantially equivalent sheets. Indeed, experimental trials have shown that several cycles of rotation or flapping in the stripping machine may be required to separate such sheets and in some cases they may split in a manner similar to that shown in Figure 3.

In Figure 6, the groove 70 is narrower and deeper. This creates a greater resistance to deposition of copper ions that enter V-groove 150 of Figure 4 or V-groove 60 of Figure 5. In some cases, copper will not deposit throughout V-groove 70 and particularly not near the apex of the V-groove. This causes a bridging 80 of metal across the V-groove. This bridging of metal across the V-groove avoids formation of the line of weakness in the arc of the V-groove. The bridge 80 can act to strongly bind the two sides of the metal envelope which, once again, may result in the deposited metal requiring several cycles of rotation or flapping to separate into two sheets which, most likely, will not be substantially equivalent in size.

In another embodiment of the present invention, which is particularly suitable for electro winning processes, the V-groove can be sized and shaped to trap gaseous material which further acts to define a line of weakness in the arc of the groove.

It will be appreciated that variations may be made to the process and apparatus described herein without departing from the spirit or scope of the present invention.

CLAIMS

1. A method of electro-depositing an envelope of metal on a cathode said envelope including deposited metal on either side of said cathode joined along at least one edge by a frangible portion, and being removable from said cathode by rotation of respective sides of the deposited metal envelope about the frangible portion to separate the deposited metal from the cathode into two substantially equivalent sheets,

the method comprising providing a groove on said cathode plate whereby metal deposited on and adjacent to said groove forms said frangible portion,

and wherein said groove is shaped such that a line of weakness is formed in the metal deposited within the groove such that separation of the two sheets of deposited metal is initiated along said line of weakness.

2. A method as claimed in claim 1 wherein the groove is shaped as a V, the line of weakness being formed within the arc of the V.

3. A method as claimed in claim 1 or claim 2 wherein the sides of the groove are between 75 and 150° apart.

4. A method as claimed in any one of the preceding claims wherein the sides of the groove are 90° apart.

5. A method as claimed in any one of the preceding claims wherein the groove is shaped to allow deposition of metal directly adjacent the apex of the groove.

6. A method as claimed in any one of the preceding claims wherein the groove is shaped to permit deposited metal to substantially fill the entire groove.

7. A method as claimed in any one of the preceding claims wherein the groove is shaped to capture gas rising from below the cathode plate during deposition of metal.

8. A cathode plate for electro-deposition of an envelope of metal, said cathode plate having a groove along at least one edge and shaped such that, in use, a line of weakness is formed in the metal deposited within the groove,

whereby during stripping of metal from said cathode, separation of the envelope of metal into two substantially equivalent sheets is initiated along said line of weakness.

9. A cathode plate as claimed in claim 8 wherein the groove is shaped as a V, the line of weakness being formed within the arc of the V.

10. A cathode plate as claimed in claim 8 or claim 9 wherein the sides of the groove are between 75 and 150° apart.

11. A cathode plate as claimed in any one of claims 8 to 10 wherein the sides of the groove are 90° apart.

12. A cathode plate as claimed in any one of claims 8 to 11 wherein the groove is shaped to allow deposition of metal directly adjacent the apex of the groove.

13. A cathode plate as claimed in any one of claims 8 to 12 wherein the groove is shaped to permit deposited metal to substantially fill the entire groove.

14. A cathode plate as claimed in any one of claims 8 to 13 wherein the groove is shaped to capture gas rising from below the cathode plate during deposition of metal.

15. A method of electro-depositing an envelope of metal on a cathode substantially as herein described with reference to any one of the embodiments of the invention illustrated in the accompanying drawings and/or examples.

16. A cathode plate for electro-deposition of an envelope of metal substantially as herein described with reference to any one of the embodiments of the invention illustrated in the accompanying drawings and/or examples.

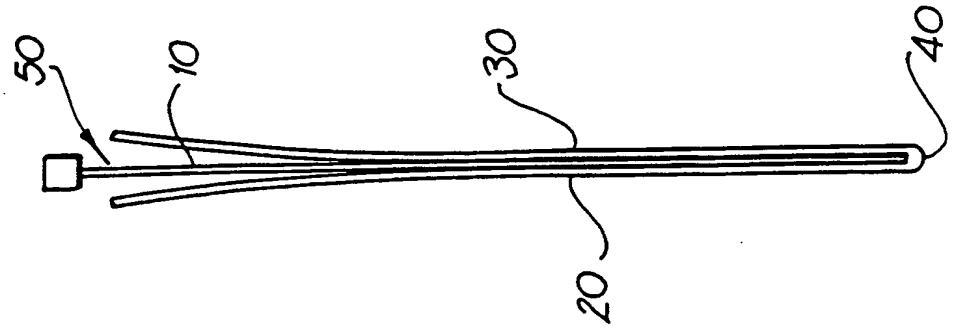

FIG. 1D
PRIOR ART

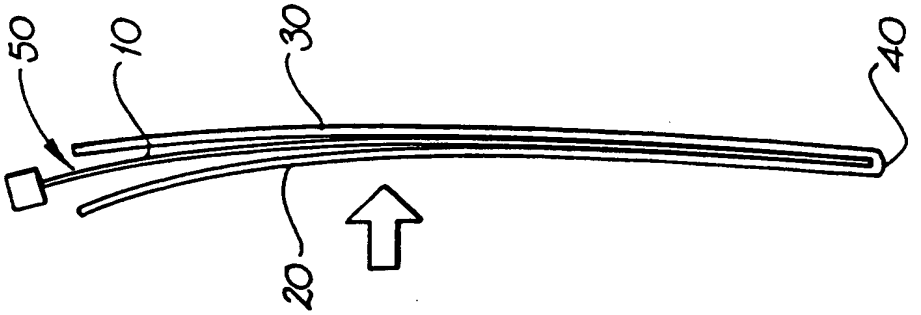

FIG. 1C
PRIOR ART

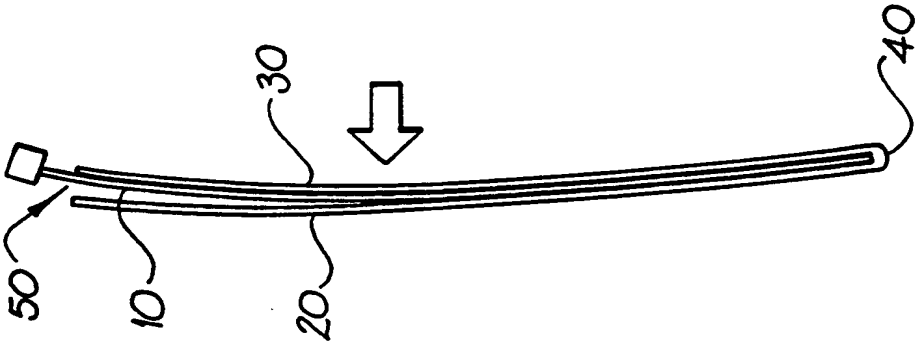

FIG. 1B
PRIOR ART

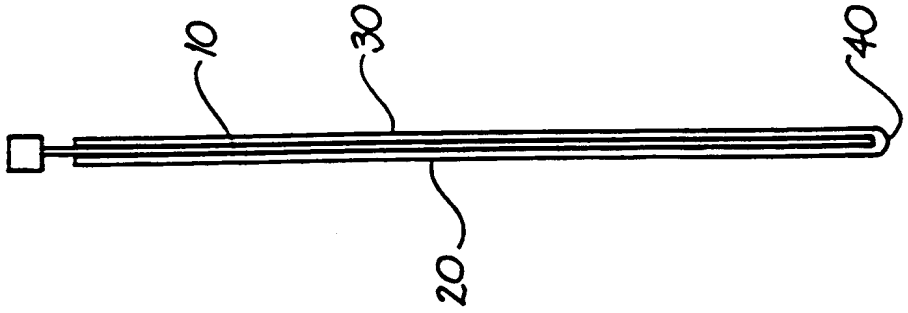

FIG. 1A
PRIOR ART

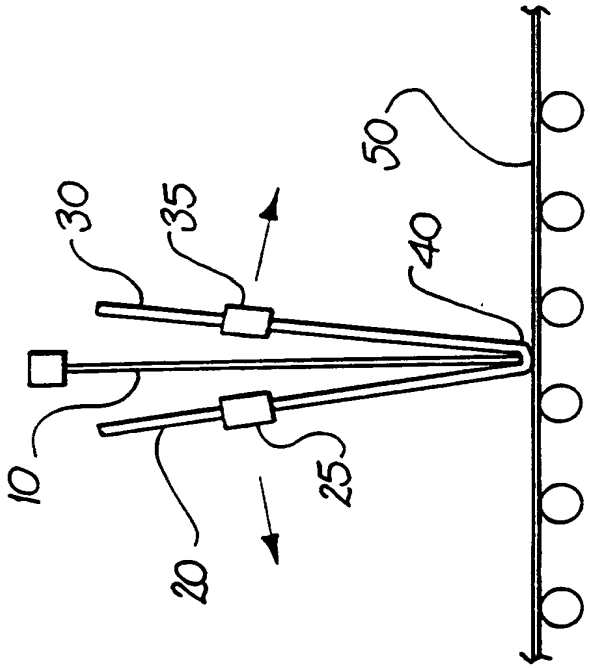

FIG. 2B
PRIOR ART

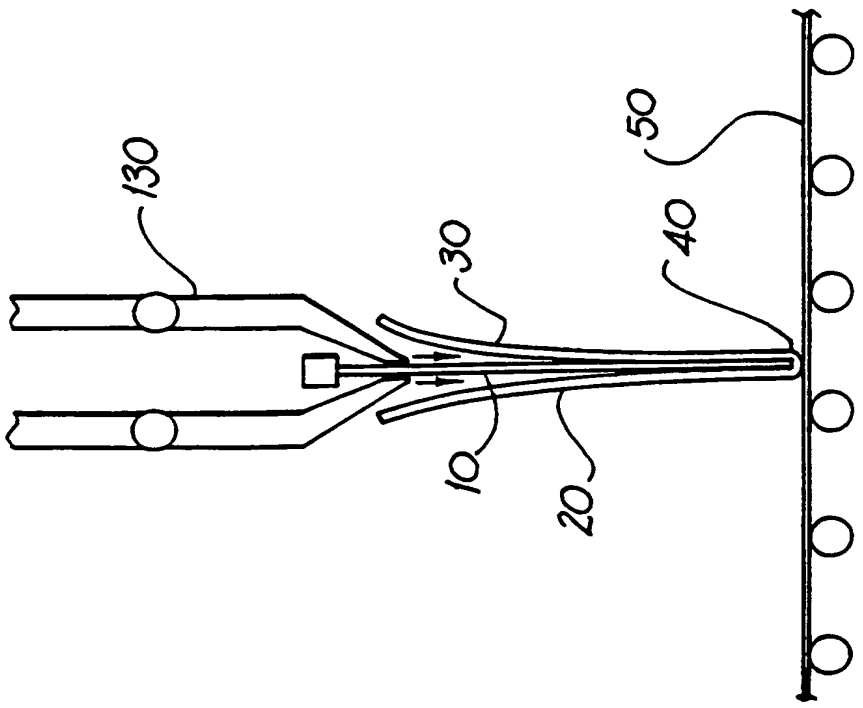

FIG. 2A
PRIOR ART

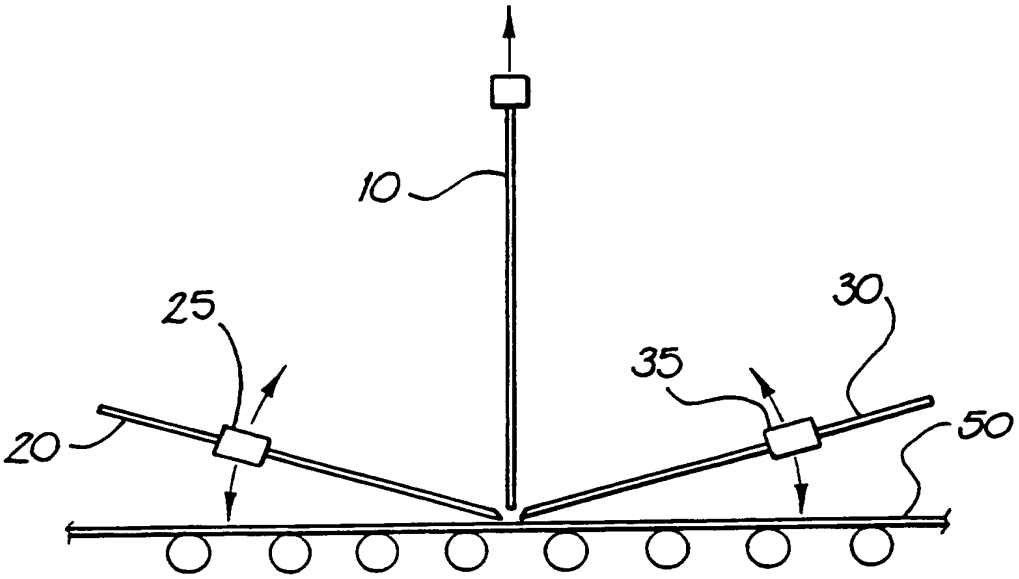

FIG. 2C
PRIOR ART

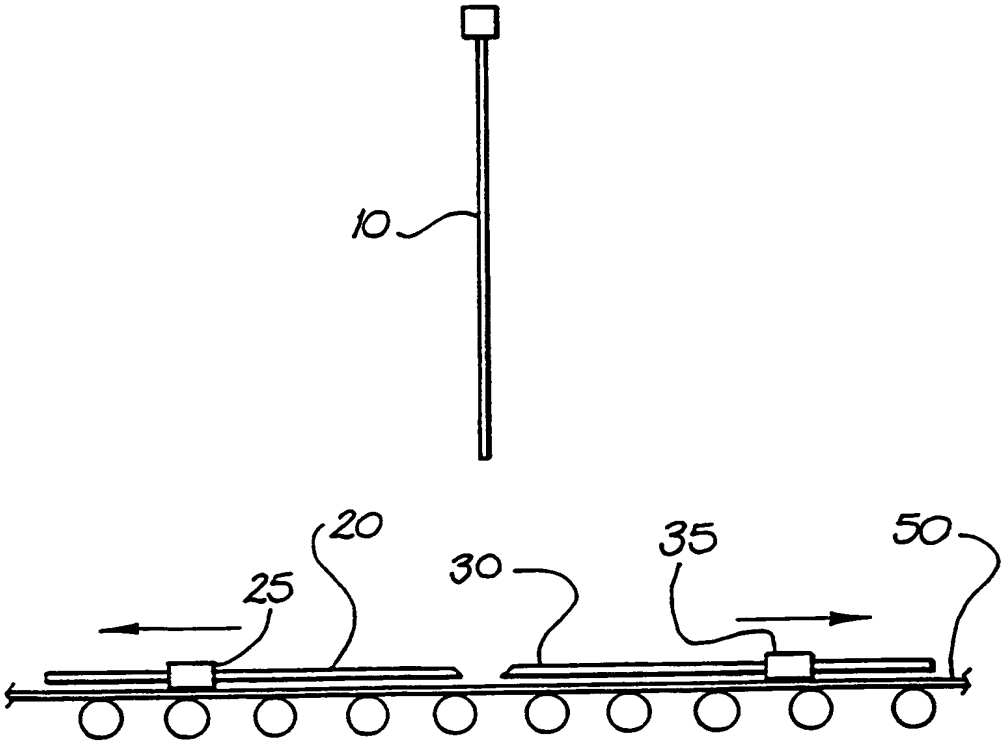

FIG. 2D
PRIOR ART

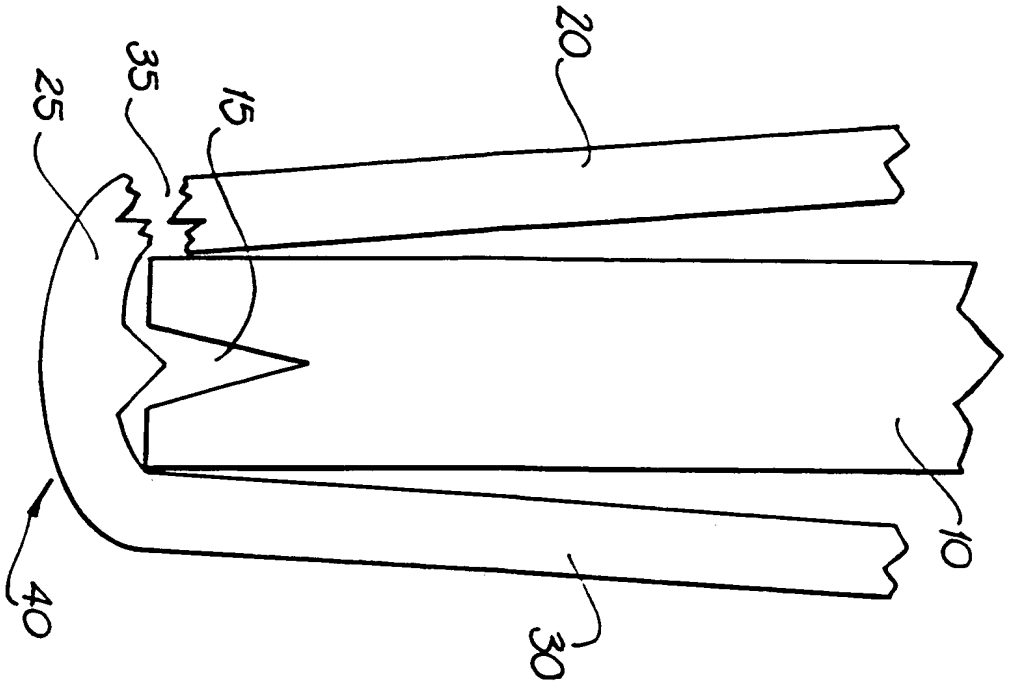

FIG. 3
PRIOR ART

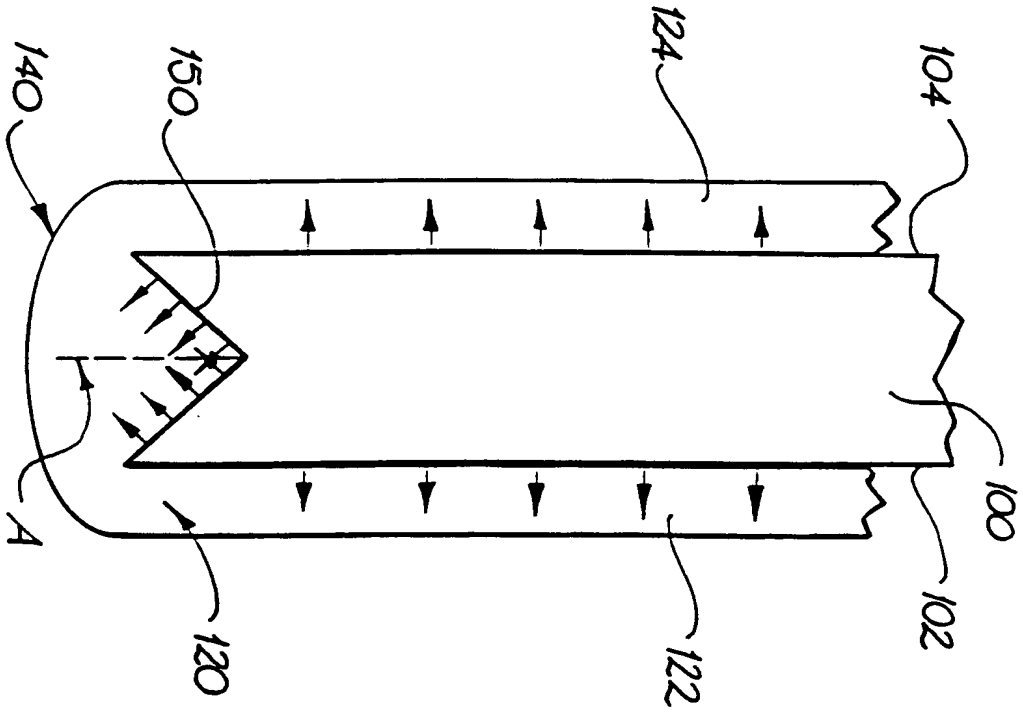

FIG. 4

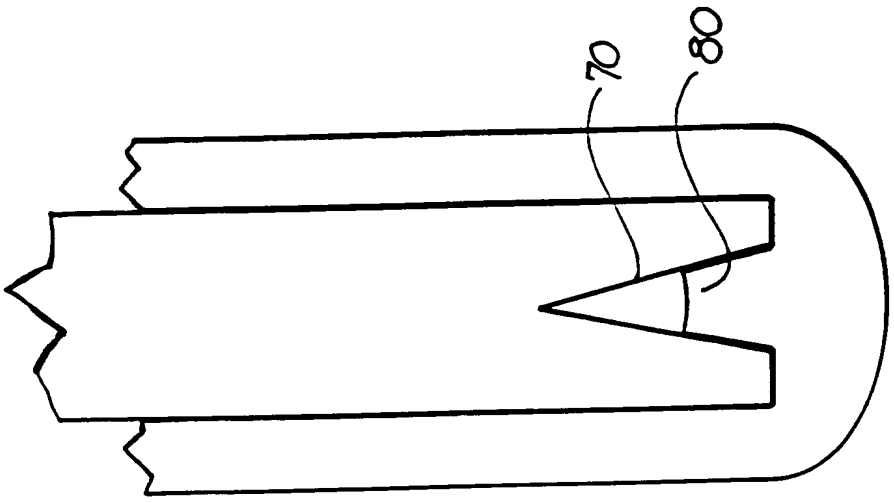

FIG. 6

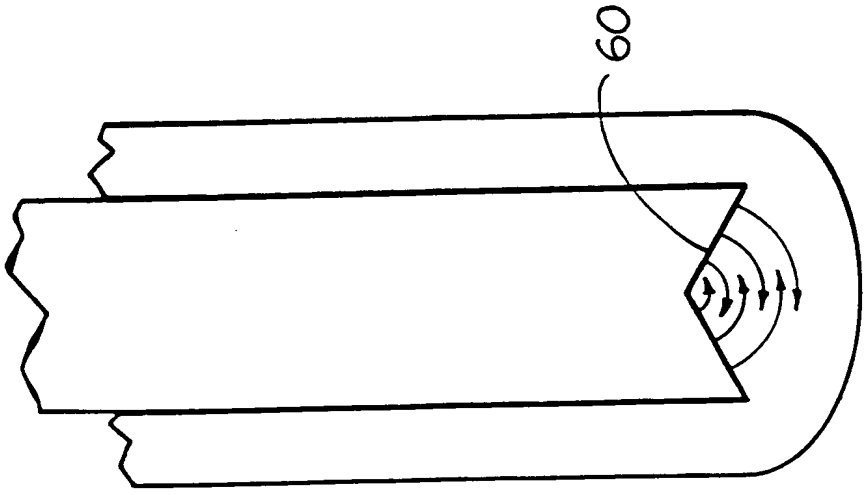

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 00/00669

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[7]:

C25C 7/08, 7/02, 1/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C25C 1/12, 7/IC + KEYWORDS

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

AU:IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPAT: (GROOV:OR SLOT: OR CHANNEL) AND CATHOD: OR PLAT:OR COPPER OR Cu)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	AU 78858/87 A (OUTOKUMPU OY) 14 April 1988	
A	GB 2196989 A (MIM TECHNOLOGY MARKETING LIMITED) 11 May 1988	

☐ Further documents are listed in the continuation of Box C

☒ See patent family annex

* Special categories of cited documents:

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

04 July 2000

Date of mailing of the international search report

21 JUL 2000

Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE
PO BOX 200
WODEN ACT 2606 AUSTRALIA
E-mail address: pct@ipaustralia.gov.au
Facsimile No.: (02) 6285 3929

Authorized officer

ASOKA DIAS-ABEYGUNAWARDENA

Telephone No.: (02) 6283 2141

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/ AU/00669

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
GB	2196989	AU	80573/87	CA	1317907	DE	3737176
		SE	8704295	US	4840710		

END OF ANNEX